Stop the INVASION

GET THE FACTS

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YOU CAN HELP PREVENT THE DAMAGE CAUSED BY INVASIVE SPECIES TO CALIFORNIA'S SPECIALTY CROPS.

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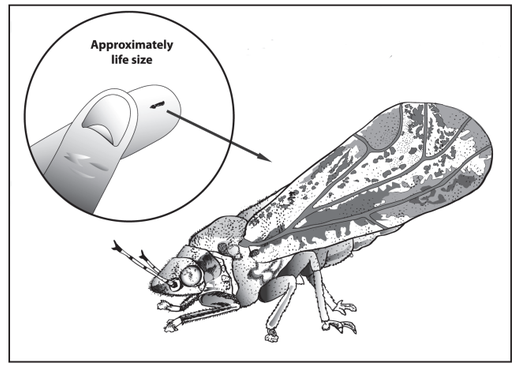
California Foundation for Agriculture in the Classroom

Invasive Species Fact Sheet

Asian Citrus Psyllid

Background – Invasive species are organisms that are moved by nature, people, or animals into an ecosystem where they have not been previously found. Some of these organisms are spread naturally or accidentally by people, while others are spread intentionally, without understanding the harm they might cause. Although most of the organisms brought into our state cause no harm, a few are able to thrive in California to the detriment of native ecosystems, recreation, agriculture, including specialty crops, infrastructure, and public or animal health. These invasive species include plants and animals, insects and other arthropods, and pathogens.



Description: A tiny bug called the Asian citrus psyllid is a big problem for citrus growers, home gardeners, and anyone who enjoys eating citrus. The Asian citrus psyllid threatens all citrus varieties and a few ornamental plants, because it can transfer a bacterium that causes huanglongbing [hwang-long-bing] (HLB) disease, also known as “citrus greening disease.”

The Asian citrus psyllid adult is approximately the size of a sesame seed and has mottled brown wings. When the adult feeds it tilts its hind end at a 45-degree angle, making it look like a thorn on leaves and stems. Female Asian citrus psyllids lay hundreds of eggs in their lifetime, usually on new shoots and leaves. Asian citrus psyllid juveniles, or nymphs, are yellow in color and produce sugary ‘honeydew’ from the plant liquids they eat. Waxy, white tubules can be seen extending from their hind ends to move honeydew away from their bodies so they don’t drown in it.

Habitat: The Asian citrus psyllid and HLB came from southern Asia and citrus psyllids were first discovered in North America, in Florida in 1998. The Asian citrus psyllid has since spread through parts of the United States and Mexico. HLB is also gradually spreading along with the psyllid. Psyllids feed on leaves and stems of all citrus varieties.

How Asian citrus psyllid and HLB are spread: The Asian citrus psyllid spreads by flying from citrus tree to citrus tree and HLB spreads when an Asian citrus psyllid picks up the bacteria by feeding on an infected plant, then flies to another plant and feeds again. Psyllids can travel long distances when people transport infested plants or plant debris from one area to another. This can lead to infestations in new regions or states.

Why it is a problem: The Asian citrus psyllid is dangerous because it can infect citrus trees with the bacterium that causes HLB, the worst citrus disease in the world. There is no cure for the disease and infected trees will eventually die. Homeowners and farmers must remove and destroy infected trees to prevent further spread of the disease.

HLB has killed many citrus trees in Asia, India, parts of the Middle East, South America, and Florida, and is now threatening citrus production in California, which is a $2.1 billion industry. California is the nation’s primary source of fresh market oranges, producing 80 percent, and also supplies 87 percent of the nation’s lemons.

How it affects California specialty crops: Many of the affected crops are California specialty crops. Specialty crops are fruits and vegetables, tree nuts, dried fruits, and horticulture and nursery crops (including floriculture). Many of the fruits, nuts, and vegetables eaten in the United States are grown right here in California. The Asian citrus psyllid could destroy these citrus crops including orange, lemon, lime, mandarin, kumquat, and grapefruit.

How you can help: Only purchase citrus trees from a good nursery close to your home and do not transport citrus trees to other areas. Anyone with citrus trees should inspect young leaves whenever watering or pruning. Always bag or dry out citrus prunings before disposing of them so psyllids don’t hitch a ride to new places. Before transporting fruit, remove stems and leaves to make sure there are no psyllids. If an Asian citrus psyllid is found, report it to local agriculture authorities.

For Additional Information:
California Department of Food and Agriculture
1220 N Street
Sacramento, CA 95814
Pest Hotline: (800) 491-1899
www.cdfa.ca.gov/plant/acp
www.californiacitrusthreat.org

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Asian Citrus Psyllid Activity Sheet

Asian citrus psyllid nymphs can be identified by the waxy tubules that they secrete.

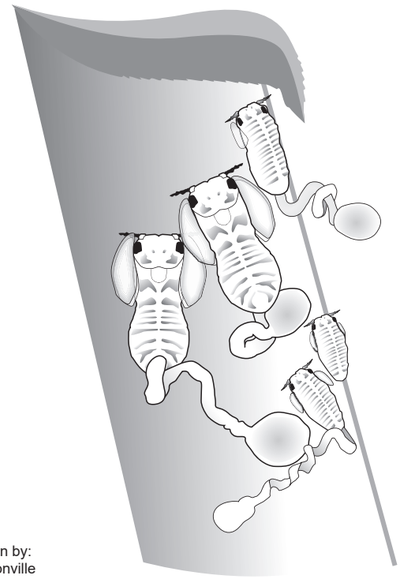


Illustration by:
Gwen Conville

Fantastic Facts

1. What is the Asian citrus psyllid?
2. What does the Asian citrus psyllid adult look like on leaves and stems?
3. How do you cure trees infected with huanglongbing disease?
4. What percentage of fresh oranges sold in the U.S. are grown in California?
5. Name two things you can do to help stop the spread of Asian citrus psyllid.

1) A tiny insect that threatens citrus 2) A thorn 3) No cure 4) 80% 5) Buy local plants, inspect citrus fruit and trees, wipe off fruit and remove leaves and stems, bag or dry out green waste

Lesson Ideas

- Create a comic strip featuring the Asian citrus psyllid and its destruction of citrus.
- Research the latest psyllid appearances and mark on a map how close the psyllid is to your home.
- Write a persuasive essay on the importance of keeping pests like the psyllid out of California.
- In groups, create a psyllid model out of recycled materials. Give each creation a creative name.

Lesson Plan: Stop the Psyllid

Introduction: To understand the economic impact of Asian citrus psyllid and huanglongbing disease, students will act as citrus growers managing a navel orange farm. ACP and HLB will be introduced into the orchard and students will calculate the point at which their orchard is no longer profitable.

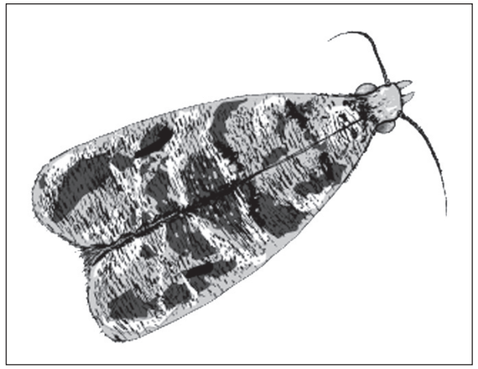
Materials:
- You Tube Video: “Deadly Huanglongbing Disease Threatens California Citrus” www.goo.gl/vUczj6
- You Tube Video: “Detecting Asian Citrus Psyllid” www.goo.gl/sD3ccM
- Paper, colored pencils

Procedure:
1. Play both videos and discuss psyllid identification and damage caused by HLB disease.
2. Have students pair up to be “farmers” who own a 100-acre orange farm.
3. Project the template found at www.LearnAboutAg.org/resources/fact/asian_citrus_temp.pdf. Students should use this template to draw their own chart to show what’s happening in the citrus orchard at each stage of infestation. Chart boxes should be large enough for students to draw a picture of the orchard and write down the costs associated with ACP and HLB.
4. Students should use the following information to predict when the citrus farm is no longer profitable:
   - Trees take at least 5 years to start producing fruit.
   - HLB disease takes several years to start affecting fruit production. It can kill a tree in about five years. Diseased trees must be removed.
   - There are 100 trees per acre in the orchard
   - Profit per acre = $2,500 ($25/tree)
   - Annual cost of pesticides to control ACP = $500/acre applied every year after ACP has been detected
   - Tree replacement costs = $25/tree
   - At what point is it no longer profitable to farm citrus?
5. Why is it important to stop the spread of Asian citrus psyllid and HLB?

Invasive Species Fact Sheet

European Grapevine Moth

Background – Invasive species are organisms that are moved by nature, people, or animals into an ecosystem where they have not been previously found. Some of these organisms are spread naturally or accidentally by people, while others are spread intentionally, without understanding the harm they might cause. Although most of the organisms brought into our state cause no harm, a few are able to thrive in California to the detriment of native ecosystems, recreation, agriculture, including specialty crops, infrastructure, and public or animal health. These invasive species include plants and animals, insects and other arthropods, and pathogens.



Description: The European grapevine moth (EGVM) causes major damage to flowers and berries of grapevines. Adult moths are about a quarter of an inch long with wings that are tan with patches of gray, blue, black and brown. Female moths will only mate once in their life time and can lay approximately 35 eggs each day for six days following mating. Eggs are round and flat and are laid individually or in groups of two to three near grape buds, fruit, and flowers. The larvae, or caterpillars, that emerge from the eggs will grow to about one-and-a-half centimeters long. Their coloring can vary from light yellow-green to pale brown with a darker colored head. The pupa is dark brown and is wrapped in a light-gray cocoon, usually in a rolled-up leaf or under bark.

Habitat: The European grapevine moth is from Italy and was first discovered in the United States in 2009 in Napa County, California. The EGVM has become a serious pest to vineyards throughout Europe, the Middle East, Northern and Western Africa, Southern Russia, Japan, and Chile.

How they spread: The European grapevine moth can only fly one-tenth of a mile. However, they can travel long distances if people unknowingly transport grapes, nursery plants, and vineyard farm equipment that carry the moths, larva, pupae, or eggs.

Why the EGVM is a problem: The European grapevine moth can produce up to three generations of offspring each year in California, where it has no natural predators to reduce its population. The caterpillar stage causes a lot of damage. For example, caterpillars that hatch early in spring feed on the grape flowers. The second generation of caterpillars usually hatch in mid-summer and feed on the developing grapes. Sometimes a partial, third generation of caterpillars hatch in late summer and feed on ripening grapes. They also spin webbing around grape bunches and their feeding can lead to fungal infection and grape rot. Grapes are one of California’s most valuable crops and California is the top grape producer in the U.S. Losing this crop would cause serious losses for farmers and would cause the prices of grapes, raisins, and wine to go up.

How it affects California specialty crops: Many of the affected crops are California specialty crops. Specialty crops are fruits and vegetables, tree nuts, dried fruits, and horticulture and nursery crops (including floriculture). Many of the fruits, nuts, and vegetables eaten in the United States are grown right here in California. Although grapes are the European grapevine moth’s favorite food, it could also destroy other California fruits including cherry, currant, kiwi, olive, nectarine, peach, persimmon, and pomegranates, as well as plants such as rosemary.

How you can help: Keep an eye out for EGVM if you have grapevines in your yard. If you prune your grapevines, make sure to properly dispose of cuttings in your green waste container or burn them if you have a burn permit. Contact your county agriculture commissioner if you think you have found a European grapevine moth.

For additional information:
California Department of Food and Agriculture
1220 N Street
Sacramento, CA 95814
Pest Hotline: (800) 491-1899
www.cdfa.ca.gov/plant/egvm

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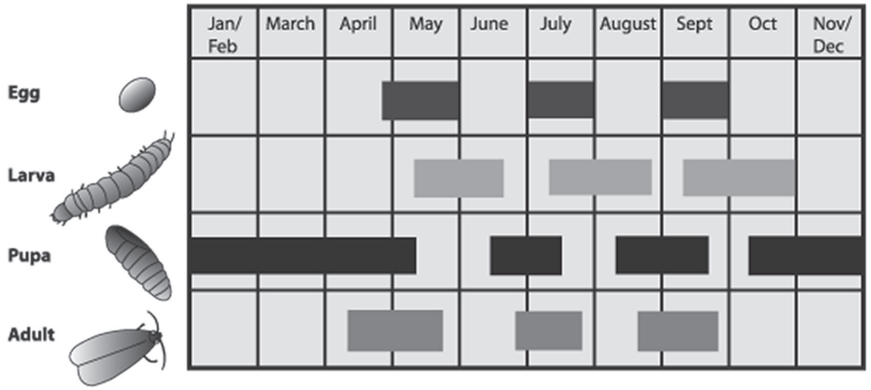
European Grapevine Moth Activity Sheet

Life Cycle of European Grapevine Moth



Bayer CropScience, Italy

Fantastic Facts

1. What is the EGVM?
2. What California crop could the EGVM destroy?
3. What are some other plants EGVM has been known to feed on?
4. What color are the wings of EGVM?
5. How can you help prevent the spread of EGVM?

1) The European grapevine moth causes major damage to flowers and berries of grapevines 2) Wine, grapes, and raisins 3) Cherry, currant, kiwi, olive, nectarine, peach, persimmon, pomegranates, and rosemary 4) Tan-cream in color, with grey-blue, brown and black blotches

Lesson Ideas

- Use the diagram above to describe the life cycle of an EGVM.
- Create informational posters about the EGVM and why it's a problem.
- In groups write skits about how the EGVM could affect a vineyard. Characters can include farmers, vineyard workers, visitors, pests, etc. Perform skits to other classes.

Lesson Plan: Buggy Travel Guide

Introduction: This activity will help students understand optimal conditions for the EGVM. Students will create moth travel brochures for a California destination where they could flourish.

Materials: travel brochures, computer, and internet access

Procedure:

1. Begin with a class discussion on invasive species and their impact on California agriculture and the environment. Highlight information about the EGVM.
2. Have students research the EGVM's ideas destination.
3. Acting as tour guides, students use their travel brochures to present how the EGVM could travel to a California region, and why they chose their location.
4. Students can include simple steps people could take to prevent the spread of the EGVM to these new areas of California.

Things to include in brochure:

- Background including why the EGVM could live there
- Location, including a map
- Climate and overall weather conditions
- Mode of transportation EGVM could use to get to new location
- Pictures/graphics
- Hazards of the EGVM and the impact it will have on the area

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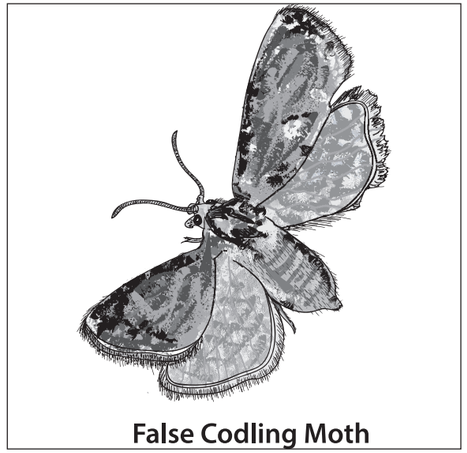
Invasive Species Fact Sheet

False Codling Moth

Background – Invasive species are organisms that are moved by nature, people, or animals into an ecosystem where they have not been previously found. Some of these organisms are spread naturally or accidentally by people, while others are spread intentionally, without understanding the harm they might cause. Although most of the organisms brought into our state cause no harm, a few are able to thrive in California to the detriment of native ecosystems, recreation, agriculture, including specialty crops, infrastructure, and public or animal health. These invasive species include plants and animals, insects and other arthropods, and pathogens.



False Codling Moth

Description: The false codling moth is a danger to fruits and vegetables because its caterpillars burrow into fruit and eat it. Each adult is tiny – its wingspan is only ⅜ to ⅝ of an inch across and the body is only about ¼ to ⅓ of an inch long. They are brownish-gray, dark brown, or black in color. The moth's eggs are white and as small as a pencil dot (1 mm). Its caterpillars start out yellow and white with dark spots, then turn pink or red with a yellow-brown head as they get older.

Habitat: The false codling moth is originally from Africa. It has been stopped at international borders to the United States over 1500 times since 1984. Live caterpillars were found at border stations in 2005, and a single moth was captured in Ventura County in 2008.

A female moth can lay up to 400 eggs on growing fruit. After about two weeks the eggs grow into yellow and white caterpillars with dark spots. They eat their way into fruit they eggs were laid on. As they grow they turn red or pink with a yellow-brown head. After about a month when the caterpillars have grown, they drop down on a silken thread and make a brown cocoon in the dirt or in tree bark. They will develop into a moth and start the cycle again.

How they spread: The main way these moths travel is inside fruits and vegetables moving from place to place.

Why it is a problem: This moth is not yet present in California. If it became established here, it would be a serious problem. Their caterpillars need fruit to grow, and the caterpillars destroy the fruit as they eat it. Because of the destruction, farmers will have to pay for ways to get rid of the pests. Higher costs and damaged fruit to the farmer means shoppers will pay more for fruits, nuts, and vegetables.

How it affects California specialty crops: Many of the affected crops are California specialty crops. Specialty crops are fruits and vegetables, tree nuts, dried fruits, and horticulture and nursery crops (including floriculture). Many of the fruits, nuts, and vegetables eaten in the United States are grown right here in California. The false codling moth could destroy these California crops: grapes, peach, plum, cherry, beans, tomato, pepper, persimmon, apricot, olive, pomegranate, English walnut, and corn.

How you can help: The best way you can help is to not bring in fruits, vegetables, and plants from out of the state or out of the country. If you find fruit with worms in it, place them in a sealed container and take it to your county agriculture commissioner's office. Infected fruit usually has ugly scars on the outside.

There are methods that could be used to eliminate the false codling moth if it became established in the United States. These include "male attractant technique" (traps using a synthetic pheromone as a lure) and closing a farm area that has infested fruit. However, keeping the moth from becoming established here in the first place is the safest and cheapest option.

For more information contact:
California Department of Food and Agriculture
1220 N Street
Sacramento, CA 95814
Pest Hotline: (800) 491-1899
www.cdfa.ca.gov

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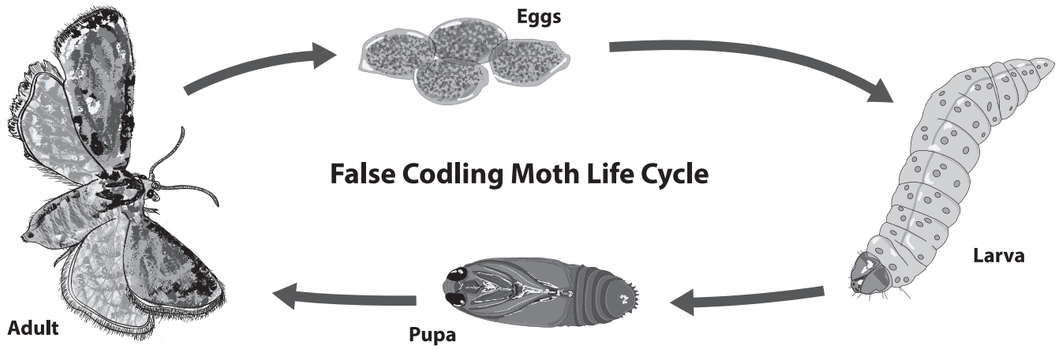
False Codling Moth Activity Sheet

Life Cycle of False Codling Moth



Fantastic Facts

1. How big is the false codling moth?
2. Where do these moths make their cocoons?
3. What is the main way these insects travel?
4. What are two California crops that are in danger from the false codling moth?

1) ½" across by ¼" long 2) 24 years 3) In the dirt or the bark of trees 4) Inside fruits and vegetables 5) Examples include: grapes, peach, plum, cherry, beans, tomato, pepper, persimmon, apricot, olive, pomegranate, English walnut, and corn.

Lesson Ideas

- With 1" graph paper try to draw an actual size false codling moth. Then draw a larger copy using the scale ½" = ½'.
- Create a Venn Diagram comparing and contrasting the false codling moth and European grapevine moth.
- Write a pretend letter to your friend in Africa about the false codling moth. Kindly explain why he/she shouldn't mail you any fruits or vegetables.

Lesson Plan: Smuggler Bugs

Introduction: Students will write and perform a play around the central theme of pests trying to sneak into the state. Students will gain a deeper understanding of the false codling moth as they become more familiar with story elements and each other.

Materials:
Paper, pencils, poster-sized paper, examples of play scripts

Procedure:
1. Have the students read a few fact sheets to become familiar with key points concerning invasive species.
2. Explain to them that they will be writing and performing a play. The false codling moth will be the villain. Have examples of other plays available for students to see.
3. Student scripts should include story elements such as:
    - Characters
    - Setting
    - Dialogue
    - Conflict
    - Resolution
4. To set the mood, students can create Wanted posters of the villains to display around the classroom. They can include key information on the posters.
5. Over two or three days students will perform their plays to the class. If possible they can perform to other classes as well.

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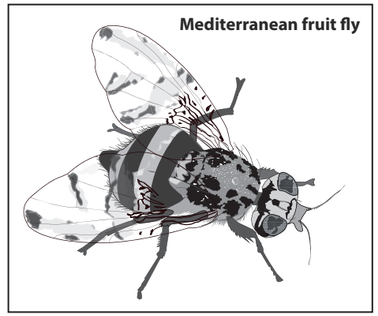
Invasive Species Fact Sheet

Mediterranean Fruit Fly

Background – Invasive species are organisms that are moved by nature, people, or animals into an ecosystem where they have not been previously found. Some of these organisms are spread naturally or accidentally by people, while others are spread intentionally, without understanding the harm they might cause. Although most of the organisms brought into our state cause no harm, a few are able to thrive in California to the detriment of native ecosystems, recreation, agriculture, including specialty crops, infrastructure, and public or animal health. These invasive species include plants and animals, insects and other arthropods, and pathogens.



Description: The Mediterranean fruit fly or medfly has been called one of the world's most destructive pests. It is a little smaller than a house fly, approximately ¼ of an inch long. It has a blackish colored mid-section marked with silver and a tan abdomen with dark stripes. Its wings are clear with light brown bands and gray flecks near the base.

Medfly eggs are tiny, white, and banana-shaped. Larvae (maggots) that hatch from eggs look like small carrot-shaped worms before they enter their resting stage, called a pupa, which looks like a brown grain of rice. A medfly can develop from an egg into an adult in about two and a half months, but the time required depends on the weather.

Habitat: The Mediterranean fruit fly is originally from Africa, but has spread to many other parts of the world including Europe, Australia, Central America, and South America. Medflies need fruit or vegetable plants to survive. The female lays her eggs inside fruit growing on a tree or vine. The fruit is destroyed when the eggs hatch and develop into larvae which eat the fruit pulp. After the infected fruit falls to the ground, the larvae leave the fruit and burrow into the ground where they develop into adult flies. The adult comes out of the ground to start the cycle again. Each fruit fly can lay about 300 eggs.

How it spreads: The medfly "hitchhikes" to California from infested areas. It comes into the state in three main ways: through mailed packages of fruit, fruit smuggling, and tourists bringing fruit back from a trip.

Why it is a problem: The medfly can live in a variety of climates and in a large variety of plants. It can attack more fruits, nuts, and vegetables than any other fruit fly. If medflies become established in California, both home gardens and farm crops would be at risk for infestations. Shoppers would pay more for fruits, nuts, and vegetables because of higher production costs and damaged crops. The medfly can attack more than 250 fruits, vegetables, and nuts.

How it affects California specialty crops: Many of the affected crops are California specialty crops. Specialty crops are fruits and vegetables, tree nuts, dried fruits, and horticulture and nursery crops (including floriculture). Many of the fruits, nuts, and vegetables eaten in the United States are grown right here in California. The medfly can attack more than 250 California plants, including: apple, apricot, avocado, bell pepper, citrus, date, fig, grape, grapefruit, guava, mango, nectarine, orange, papaya, peach, pear, persimmon, plum, pomegranate, tangerine, tomato, and walnut.

How you can help: Preventing medflies from coming into California is the best way to control this invasive pest. Make sure you don't bring fruit or vegetables to California that you purchased when on vacation out of the state or country. If you find infested fruit or vegetables, place them in a sealed container and take it to your county agriculture commissioner's office. When medflies are found, regulators limit the movement of fresh fruits and vegetables within the area. One way medflies are controlled is by breeding male flies that are infertile in the laboratory. These males are then released. When they breed with females, they are not able to produce offspring and over time, the number of flies drastically drops. Sprays may also be used on trees to prevent an outbreak medflies in an area where the flies have been detected. Traps can be placed in trees to keep track of how many flies are in the area.

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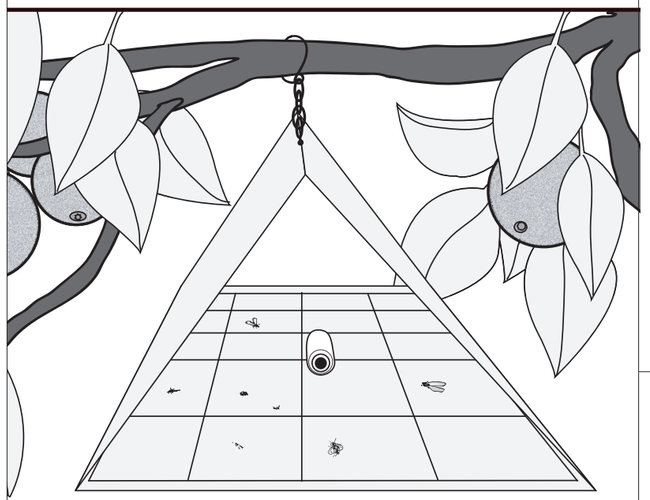
Medfly Activity Sheet

Pheromone Trap



Pheromone trap

These traps contain a pheromone or “perfume” that attracts medflies. Inspectors examine the traps to determine if medflies are in the area.

Fantastic Facts

1. How does the medfly get into California?
2. Where does the medfly lay its eggs?
3. How many plants can the medfly attack?
4. What can you do to prevent the spread of medflies?
5. What is one method that is used to control medflies?

1) “Hitchhikes” from infested areas 2) In fruit 3))250 4) Don’t bring fruit from other states or countries to California 5) Release of infertile male flies

Lesson Ideas

- Make a video or podcast service announcement about medflies.
- Invite a local fruit, nut, or vegetable farmer to visit and share how pests affect his/her business.
- Bring unblemished and damaged fruit to class. Create a skit of a grocery store scene to demonstrate how damaged fruit is not as desirable to most consumers and discuss any problems this can cause.

Lesson Plan: Fly Fragrances

Introduction: For students to understand the role of regulatory agencies in the protection of agricultural crops, they need to become aware of procedures to ensure that invasive pests do not establish themselves in California. In order to detect the presence of medflies, trappers use sticky traps that contain a pheromone or “perfume” to attract medflies. Students will determine which perfumes are most enticing and then create their own insect sticky trap.

Materials: cardboard, bottles, tape, paperclips, petroleum jelly, marker, cotton balls, perfumes

Procedure:

1. Introduce students to a variety of perfumes. Have one student in each corner of the room with a different perfume. The remainder of the students move to the perfume they think smells the best. Record the results and discuss the findings with the class. Explain how the male medfly finds a female medfly through pheromones (perfume). Inspectors use this pheromone in their sticky traps to attract male medflies.
2. Have students bring in materials to create their own medfly trap using cardboard, milk cartons, poster board, and tape. A grid should be created on the bottom to allow students to count each square. A cotton ball with their choice of perfume should be taped to the top of the trap.
3. Students then hang their traps from trees and count the number of insects that land in their trap for one week.
4. Students can compare their data with other students in the class to see which “pheromones” attracted more insects. Explain that inspectors use these techniques to detect the presence of medflies in their area.
5. Have a state trapper come into the class to show a real medfly trap and discuss the process.

Invasive Species Fact Sheet

Oriental Fruit Fly

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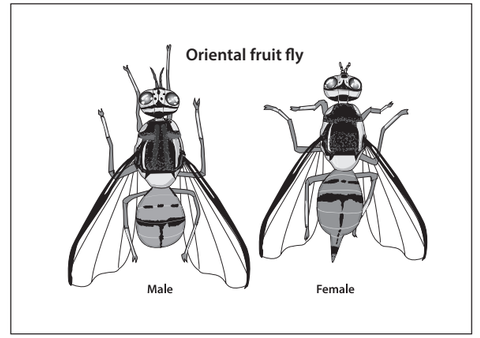

Description: The oriental fruit fly is a harmful pest to fruits and vegetables. The adult is a little larger than a common house fly. Its body is approximately ⅓ of an inch long and its clear wings are approximately ⅓ of an inch long. Oriental fruit flies are usually yellow and dark brown with black markings. The female has a pointed abdomen to lay her eggs inside fruit. These fruit fly eggs are tiny, long, white, and banana-shaped. Larvae that hatch from eggs look like little white worms. An oriental fruit fly can develop from an egg into an adult in only 16 days if the weather is warm enough.

Habitat: The oriental fruit fly came from Taiwan, and is now a problem in most of Asia and Hawaii. It has come into California many times since 1960 in fruit and vegetables, but has been taken care of each time. The oriental fruit fly can live anywhere there are fruits and vegetables, year round. The female lays about 20 eggs at a time inside fruit. The eggs hatch and develop into larvae (also called maggots) which eat and tunnel through the fruit pulp. After about ten days, the maggots eat a hole in the fruit and fall to the ground, where they burrow into the dirt and wait another ten days to grow into adult flies. The adult comes out of the ground to start the cycle again. Each female fruit fly can lay about 1,500 eggs in her life.

How they spread: The most common way oriental fruit flies come into California is inside infested fruit from another place. Once they are in the state, these fruit flies can fly up to 30 miles looking for new fruit.

Why it is a problem: Oriental fruit flies can infest new areas very quickly because of how far they can fly. They also have very short life cycles compared to other fruit flies, so they can lay a lot more eggs. This makes a small problem quickly become a serious problem for farmers. Some farmers have had their entire crop destroyed by this fruit fly. It has been estimated that if the oriental fruit fly became a problem in California, it could cost as much as $175 million from destroyed crops and other needed costs. Shoppers would also pay more for fruits, nuts, and vegetables because of higher costs and damaged crops.

How it affects California specialty crops: Many of the affected crops are California specialty crops. Specialty crops are fruits and vegetables, tree nuts, dried fruits, and horticulture and nursery crops (including floriculture). Many of the fruits, nuts, and vegetables eaten in the United States are grown right here in California. The oriental fruit fly has attacked around 200 different kinds California crops, including: pears, plums, cherries, peaches, apricots, figs, citrus, tomatoes and avocados.

How you can help: The most helpful action you can take is to not bring in fruits, vegetables, and plants from out of the state or out of the country. This stops oriental fruit flies from coming in the first place. If you find infested fruit or vegetables, place them in a sealed container and take it to your county agriculture commissioner’s office.

The main way California regulators control the oriental fruit fly is a strategy called the “male attractant technique.” Gel bait stations are put out for the male fruit flies. Each bait station has pesticide gel with a chemical that attracts males. The male flies die after they eat it. Another thing regulators do is limit the movement of fresh fruits and vegetables in an area where oriental fruit flies are found.

For more information contact:
California Department of Food and Agriculture
1220 N Street
Sacramento, CA 95814
Pest Hotline: (800) 491-1899
www.cdfa.ca.gov

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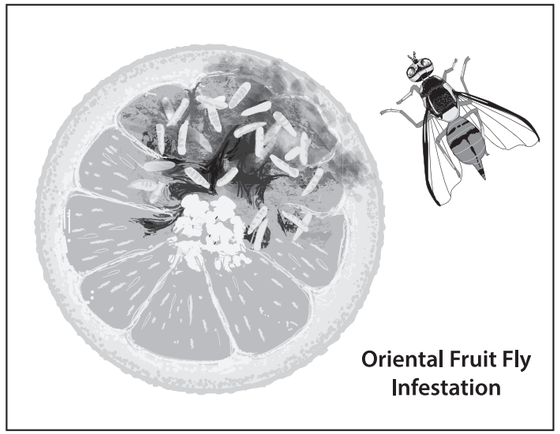
Oriental Fruit Fly Activity Sheet



Oriental Fruit Fly Infestation

Fantastic Facts

1. How is the female fruit fly different than the male?
2. Where can oriental fruit flies live?
3. What are the oriental fruit flies' favorite foods?
4. How do the oriental fruit flies get into California?
5. What is the "male attractant technique"?

1) The female has a pointy end to lay her eggs inside fruit. 2) Anywhere there are fruits or vegetables year round 3) Avocado, mango, papaya, and citrus 4) Inside infested fruit from another place 5) The main way regulators control the fly - gel pesticide bait is put out for the male fruit flies to eat.

Lesson Ideas

- Create a Venn Diagram comparing and contrasting the medfly and the oriental fruit fly.

- Using the Internet, research where the latest oriental fruit fly sightings have occurred.

- Pretend you are an oriental fruit fly and write a fruit fly autobiography.

- Create an oriental fruit fly illustration using a computer graphics program such as Paint. Share with a partner or group.

Lesson Plan: Exterminator Expo

Introduction: Students will understand what is involved in exterminating pests. In groups they will create a plan to take care of an oriental fruit fly invasion, and present this plan in an "Exterminator Expo."

Materials:
Paper, notecards, pencils, colored pencils

Procedure:
1. Students read the oriental fruit fly fact Sheet, reading closely for important details about the fruit fly.
2. Have a class discussion of factors involved with exterminating pests (ie humans and living things nearby, least amount of crop damage, pros and cons of using baits, etc).
3. Students divide into groups and decide on what they think is the overall best way to exterminate the fruit fly.
4. Each group will create a written report to present to the class. Each report should include:
   - Group members
   - Supplies needed
   - Method of extermination
   - Reason why method was chosen
   - Possible problems with using that method
   - Estimated total costs
5. If desired, the class can vote for the best way of exterminating the fruit flies.

Sources: CDFA, University of Florida Institute of Food and Ag Science, USDA

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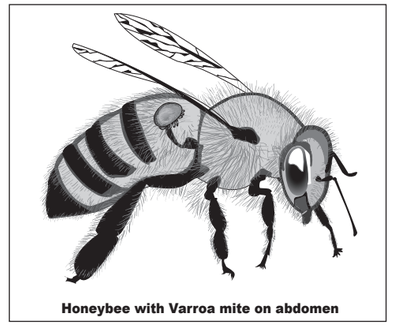
Invasive Species Fact Sheet

Varroa Mite

Background – Invasive species are organisms that are moved by nature, people, or animals into an ecosystem where they have not been previously found. Some of these organisms are spread naturally or accidentally by people, while others are spread intentionally, without understanding the harm they might cause. Although most of the organisms brought into our state cause no harm, a few are able to thrive in California to the detriment of native ecosystems, recreation, agriculture, including specialty crops, infrastructure, and public or animal health. These invasive species include plants and animals, insects and other arthropods, and pathogens.



Honeybee with Varroa mite on abdomen

Description: The Varroa mite is a tiny parasite that feeds on honeybees by consuming their hemolymph (fluid that functions like blood) and fat bodies, which functions similarly to to the liver.This can make the honeybee weak and more likely to become sick. Varroa mites look like tiny, reddish colored crabs with eight legs. Although Varroa mites seem small to us, compared to a honeybee they are relatively large. For humans, it would be the same as having a tick the size of a dinner plate on you.

Habitat: Varroa mites are from Asia. The mites have now spread throughout the United States and every continent except for Australia and Antarctica. Asian honeybees have some natural resistance to the mite, the European honeybees found in the United States are highly infected by Varroa mites. Varroa mites live on the body of adult honeybees as well as on the brood (immatures) of honeybees in the beehive. A Varroa mite lives about 50 days and they cannot survive for more than a few days without a honeybee host. The mites hide in between the parts of a bee's body, which makes it difficult for the bee to remove them.

How they spread: Mites transfer from one bee to the next when bees are in close contact with each other, such as in a hive. Mites can also spread when hives of honeybees are moved to different areas. Varroa mites likely made their way from Asia to Europe and the United States when beekeepers accidentally moved infected hives or queen bees.

Why it is a problem: Too many Varroa mites in a honeybee hive can kill all the bees in the hive because of the diseases they spread, and many bees have already died. This is a major problem for beekeepers in the U.S. When honeybee larvae are infected, they often develop with deformed wings, legs, and bodies. Varroa mites parasitize both adult and immature honeybees spreading desease, causing them to become weak, and to potentially die. Honeybee colonies that are not treated for Varroa mites usually die within one year. If honeybee colonies continue to die, crops that depend or heavily rely on pollinators will be less productive, causing food prices to go up and farmers and farm workers to lose jobs.

How it affects California specialty crops: Many of the affected crops are California specialty crops. Specialty crops are fruits and vegetables, tree nuts, dried fruits, horticulture, and nursery crops (including floriculture). Many of the fruits, nuts, and vegetables eaten in the United States are grown right here in California. Besides producing honey, honeybees are needed to pollinate about one third of the plants that we eat. This includes California crops including: strawberries, cherries, berries, melons, kiwifruit, pears, sunflowers, cucumbers, and many more. Crops like almonds would completely disappear because they depend on bees.

Methods for control: Beekeepers can check their hives for mites by using the "sugar shake method," which does not harm the bees. To do this, beekeepers use a large screen-topped jar that allows the mites to fall out but keeps the bees in. Approximately 200 to 400 bees are removed from the hive and placed in the jar at one time. (A quarter cup of bees is equal to about 200 bees.) Two tablespoons of powdered sugar are placed into the jar with the bees and the screen lid is attached before gently shaking the jar to coat bees with the powdered sugar. After letting the jar sit for a couple of minutes, the jar can be tipped upside down over a white plastic container to shake the mites out through the screen. Bees are returned to the hive where other bees clean the sugar off their bodies and they return to normal. The mites taken from the jar are counted to determine what percentage of the hive is infected. If mite levels are at or above 3%, the hive should be treated. If levels are at 10% or above it could already be too late to save the colony.

For Additional Information:
California Department of Food and Agriculture
1220 N Street, Sacramento, CA 95814
(800) 491-1899
www.cdfa.ca.gov

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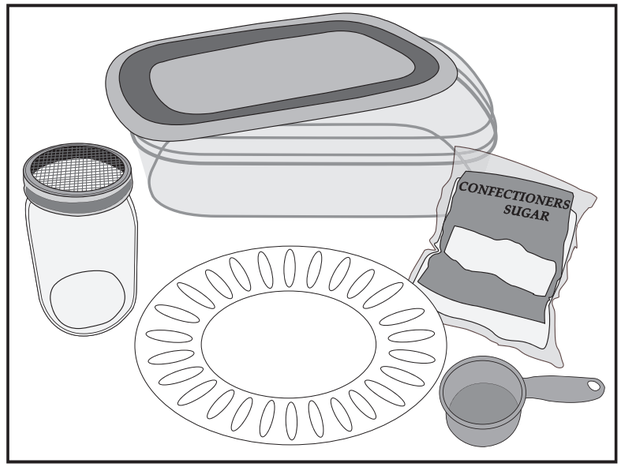
Varroa Mite Activity Sheet

Sugar Shaking



The sugar shake activity is similar to a method that beekeepers use to check their honeybee hives for mite infestation.

Fantastic Facts

1. What is the Varroa mite?
2. What impact could the Varroa mite have on the supply of fruits, vegetables, and nuts?
3. What happens to adult honeybees that are infected by mites?
4. What happens to honeybee larvae that are infected by mites?
5. Approximately what percentage of the food crops we eat must be pollinated by honeybees?
6. How does the Varroa mite spread?

1) A mite that attacks honeybees 2) Cause the decline of honeybee populations needed to pollinate many crops, thereby decreasing crop production 3) The honeybees are weakened, and could be infected with a desease 4) It weakens them, frequently leading to deformed wings and a shorter lifespan 5) Approximately 33% 6) From close contact with other bees

Lesson Ideas

- Create a comic strip showing the lifecycle of a Varroa mite in the beehive.
- Write a story about the travels of a Varroa mite.
- Have a local entomologist visit your class to discuss the Varroa mite and bee health.
- Work in teams to create Varroa mites out of paper plates and duct tape. Compete with other teams to see who can remove the mite the fastest without using hands. Create other rules as a class using your knowledge of how a Varroa mite infects a bee and what bees may do to get rid of them.

Lesson Plan: Sugar Shake Simulation

Introduction: In order to keep honeybee populations healthy, bee keepers must regularly check their beehives for mites. This will allow the bee keepers to estimate the level of mite infestation and whether or not they need to treat the colony in order to kill the mites and save the honeybees.

Materials: Beans to represent honeybees, brown cake decorating sprinkles to represent Varroa mites, canning jars, canning jar ring lids, screen purchased from the hardware or dollar store that has holes large enough for brown cake decorating sprinkles to pass through but small enough so that the beans will not pass through, powdered sugar or flour, and a table cloth

Procedure:

1. Read the fact sheet and discuss the Fantastic Fact Questions and answers as a class.
2. Tell students that they will act as beekeepers who are checking their honeybee hives for Varroa mites. Organize students into groups of two or three and instruct them to assemble their jars with screens, lids, and 100 beans.
3. Move around the room, giving each group a varying number of brown sprinkles. For example, one group might receive 5 sprinkles, while another group receives 23 sprinkles.
4. Model the steps for the sugar shake method explained on the front page in the “Methods for Control” section. Instruct students to follow the same procedure with their jars in order to determine what percentage of their hive is infected with mites. Discuss experimental error and ask students what they could do to reduce experimental error in this procedure.
5. Students should explain what their next steps should be to protect their hives from Varroa mites and how to prevent them from spreading to other areas.

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Invasive Species Fact Sheets

California Standards

6th grade

Common Core English Language Arts

RI.6.1: Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

L.6.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 6 reading and content, choosing flexibly from a range of strategies.

L.6.4a: Use context (e.g., the overall meaning of a sentence or paragraph; a word’s position or function in a sentence) as a clue to the meaning of a word or phrase.

Common Core Math

6.SP.1: Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

Next Generation Science Standards

MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

MS-LS3 Heredity: Inheritance and Variation of Traits

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

7th Grade

Common Core English Language Arts

RI.7.1: Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.7.2: Determine two or more central ideas in a text and analyze their development over the course of the text; provide an objective summary of the text.

L.7.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 7 reading and content, choosing flexibly from a range of strategies.

L.7.4a: Use context (e.g., the overall meaning of a sentence or paragraph; a word’s position or function in a sentence) as a clue to the meaning of a word or phrase.

Common Core Math

7.SP.5 Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around ½ indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.

Next Generation Science Standards

MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

8th grade

Common Core English Language Arts

RI.8.1: Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.

RI.8.2: Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.

L.8.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 8 reading and content, choosing flexibly from a range of strategies.

L.8.4a: Use context (e.g., the overall meaning of a sentence or paragraph; a word’s position or function in a sentence) as a clue to the meaning of a word or phrase.

Common Core Mathematics

8.SP.4: Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

Next Generation Science Standards

MS-LS3 Heredity: Inheritance and Variation of Traits

MS-LS4-4: Construct an explanation based on evidence

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that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

9th grade

Common Core English Language Arts

RI.9.1: Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.9.2: Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.

L.9.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 9-10 reading and content, choosing flexibly from a range of strategies.
L.9.6: Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Common Core Mathematics

9.N-Q.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in the graphs and data displays.

9.F-IF .7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

9.S-ID.1: Represent data with plots on the real number line (dot plots, histograms, and box plots).

Next Generation Science Standards

HS-LS2: Ecosystems: Interactions, Energy, and Dynamics

HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-8: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

HS-LS3 Heredity: Inheritance and Variation of Traits

HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-5: Evaluate the evidence supporting claims that chances in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

10th grade

Common Core English Language Arts

RI.10.1: Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.10.2: Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.

L.10.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 9-10 reading and content, choosing flexibly from a range of strategies.

L.10.6: Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

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Invasive Species Fact Sheet Standards (cont.)

Common Core Mathematics

10.N-Q.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in the graphs and data displays.

10.F-IF.7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

Next Generation Science Standards

HS-LS3 Heredity: Inheritance and Variation of Traits

HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-5: Evaluate the evidence supporting claims that chances in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

11th Grade

Common Core English Language Arts

RI.11.1: Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RI.11.2: Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

L.11.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11-12 reading and content, choosing flexibly from a range of strategies.

L.11.6: Acquire and use accurately general academic and domain-specific words or phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Common Core Mathematics

11.N-Q.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in the graphs and data displays.

11.F-IF.7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

11.S-ID.1: Represent data with plots on the real number line (dot plots, histograms, and box plots).

Next Generation Science Standards

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-8: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

HS-LS3 Heredity: Inheritance and Variation of Traits

HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-5: Evaluate the evidence supporting claims that chances in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

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Invasive Species Fact Sheet Standards (cont.)

12th grade

Common Core English Language Arts

RI.12.1: Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RI.12.2: Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

L.12.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11-12 reading and content, choosing flexibly from a range of strategies.

L.12.6: Acquire and use accurately general academic and domain-specific words or phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Common Core Mathematics

12.N-Q.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in the graphs and data displays.

12.F-IF.7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

12.S-ID.1: Represent data with plots on the real number line (dot plots, histograms, and box plots).

Next Generation Science Standards

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-8: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

HS-LS3: Heredity: Inheritance and Variation of Traits

HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

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HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

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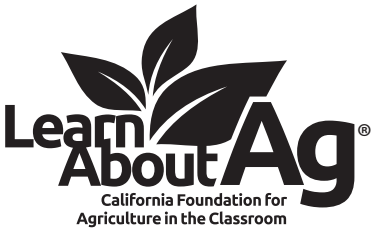

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